PB-239 708

# REPORT ON LEECH LAKE, CASS COUNTY, MINNESOTA. EPA REGION V

Pacific Northwest Environmental
Research Laboratory

Prepared for:

Minnesota Pollution Control Agency
Minnesota National Guard

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16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivded according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

| a. DESCRIPTORS | b. IDENTIFIERS/OPEN ENDED TERMS | c. COSATI Field/Group |
|---|---|---|
| eutrophication<br>lakes<br>nutrients<br>phosphorus<br>nitrogen<br>loading | | 05B<br>05C |

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# REPORT
# ON
# LEECH LAKE
# CASS COUNTY
# MINNESOTA
# EPA REGION V
# WORKING PAPER No. 105

WITH THE COOPERATION OF THE
MINNESOTA POLLUTION CONTROL AGENCY
AND THE
MINNESOTA NATIONAL GUARD
DECEMBER, 1974

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# F O R E W O R D

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nation-wide threat of accelerated eutrophication to fresh water lakes and reservoirs.

## OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

## ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

## LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Minnesota Pollution Control Agency for professional involvement and to the Minnesota National Guard for conducting the tributary sampling phase of the Survey.

Grant J. Merritt, Director of the Minnesota Pollution Control Agency, John F. McGuire, Chief, and Joel G. Schilling, Biologist, of the Section of Surface and Groundwater, Division of Water Quality, provided invaluable lake documentation and counsel during the course of the Survey; and the staff of the Section of Municipal Works, Division of Water Quality, were most helpful in identifying point sources and soliciting municipal participation in the Survey.

Major General Chester J. Moeglein, the Adjutant General of Minnesota, and Project Officer Major Adrian Beltrand, who directed the volunteer efforts of the Minnesota National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

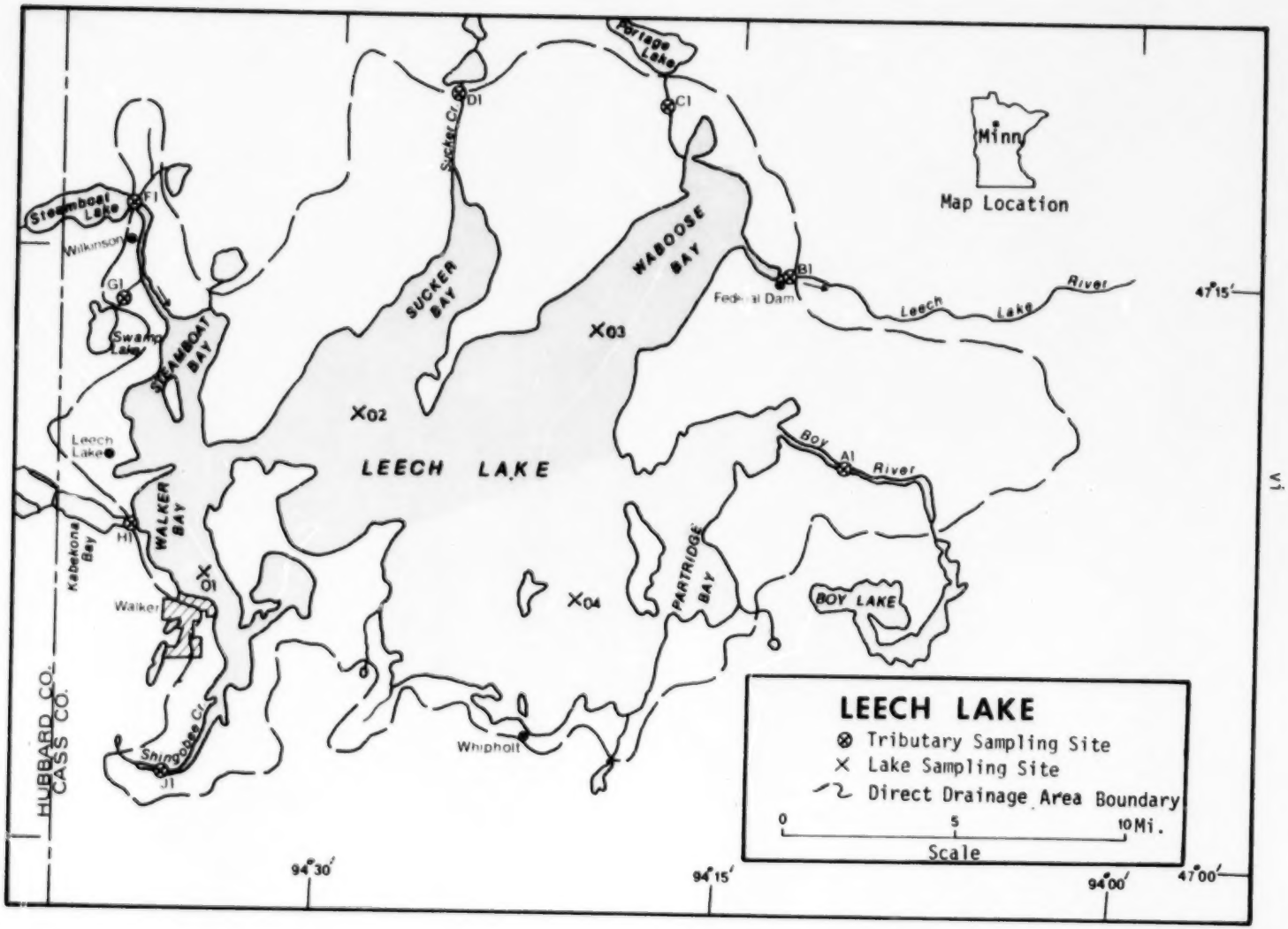
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF MINNESOTA

| LAKE NAME | COUNTY |
|---|---|
| Albert Lea | Freeborn |
| Andrusia | Beltrami |
| Badger | Polk |
| Bartlett | Koochiching |
| Bear | Freeborn |
| Bemidji | Beltrami |
| Big | Stearns |
| Big Stone | Big Stone, MN; Roberts, Grant, SD |
| Birch | Cass |
| Blackduck | Beltrami |
| Blackhoof | Crow Wing |
| Budd | Martin |
| Buffalo | Wright |
| Calhoun | Hennepin |
| Carlos | Douglas |
| Carrigan | Wright |
| Cass | Beltrami, Cass |
| Clearwater | Wright, Stearns |
| Cokato | Wright |
| Cranberry | Crow Wing |
| Darling | Douglas |
| Elbow | St. Louis |
| Embarass | St. Louis |
| Fall | Lake |
| Forest | Washington |
| Green | Kandiyohi |
| Gull | Cass |
| Heron | Jackson |
| Leech | Cass |
| Le Homme Dieu | Douglas |
| Lily | Blue Earth |
| Little | Grant |
| Lost | St. Louis |

| LAKE NAME | COUNTY |
|---|---|
| Madison | Blue Earth |
| Malmedal | Pope |
| Mashkenode | St. Louis |
| McQuade | St. Louis |
| Minnetonka | Hennepin |
| Minnewaska | Pope |
| Mud | Itasca |
| Nest | Kandiyohi |
| Pelican | St. Louis |
| Pepin | Goodhue, Wabasha, MN; Pierce, Pepin, WI |
| Rabbit | Crow Wing |
| Sakatah | Le Sueur |
| Shagawa | St. Louis |
| Silver | McLeod |
| Six Mile | St. Louis |
| Spring | Washington, Dakota |
| St. Croix | Washington, MN; St. Croix, Pierce, WI |
| St. Louis Bay | St. Louis, MN; Douglas, WI |
| Superior Bay | St. Louis, MN; Douglas, WI |
| Swan | Itasca |
| Trace | Todd |
| Trout | Itasca |
| Wagonga | Kandiyohi |
| Wallmark | Chisago |
| White Bear | Washington |
| Winona | Douglas |
| Wolf | Beltrami, Hubbard |
| Woodcock | Kandiyohi |
| Zumbro | Olmstead, Wabasha |


Minn.
Map Location
Steamboat Lake
Wilkinson
Swamp Lake
STEAMBOAT BAY
Sucker Cr.
SUCKER BAY
WABOOSE BAY
Partridge Lake
Federal Dam
Leech Lake River
47°15'
LEECH LAKE
X02
X03
X04
Leech Lake
WALKER BAY
Kabekona Bay
Walker
Boy River
PARTRIDGE BAY
BOY LAKE
Whipholt
Shingobee Cr.
HUBBARD CO.
CASS CO.
LEECH LAKE
Tributary Sampling Site
Lake Sampling Site
Direct Drainage Area Boundary
0 5 10 Mi.
Scale
94°30'
94°15'
94°00'
47°00'

LEECH LAKE

STORET NO. 2746

## I. CONCLUSIONS

### A. Trophic Condition:

Survey data show that Leech Lake is mesotrophic. Of the 60 Minnesota lakes studied in the fall of 1972, when essentially all were well-mixed, eight had less mean total phosphorus, 21 had less mean dissolved phosphorus, and seven had less mean inorganic nitrogen. Of the 80 Minnesota lakes sampled, only three had less mean chlorophyll a, and 10 had higher Secchi disc transparency.

Near-depletion of hypolimnetic dissolved oxygen occurred at station 1 in September, 1972.

### B. Rate-Limiting Nutrient:

The results of the algal assay indicate that nitrogen was limiting in Leech Lake at the time the sample was collected. Nitrogen limitation is also indicated by the lake data obtained at the time the assay sample was collected (i.e, the N/P ratio was 5/1). During the July and September sampling, the N/P ratios were greater than 14/1, and phosphorus limitation would be expected.

C. Nutrient Controllability:

1. Point sources--During the sampling year, Leech Lake received a total phosphorus load at a rate less than the rate proposed by Vollenweider (in press) as "permissible"; i.e., an oligotrophic rate (see page 14). Of that load, it is calculated that the City of Walker and the Ah-Gwah-Ching Nursing Home contributed nearly 10%.

The waste treatment facilities of the City of Walker have been upgraded to include land disposal of the effluent by spray irrigation, and the wastes from the Nursing Home are now directed to the Walker municipal system (McGuire, 1974). The new facilities became operational in November, 1973, and the discharges to Leech Lake have been eliminated.

The removal of these sources of phosphorus provides protection for the existing trophic condition of Leech Lake and should enhance water quality in the local areas of the lake formerly receiving the discharges.

2. Non-point sources (see page 14)--The phosphorus exports of the Leech Lake tributaries were quite low and probably result from the land-use practices in this largely-forested region of Minnesota.

In all, it is estimated that non-point sources contributed about 86% of the total phosphorus load reaching Leech Lake during the sampling year.

## II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

### A. Lake Morphometry†:

1. Surface area: 112,000 acres.
2. Mean depth: 15.5 feet.
3. Maximum depth: 150 feet.
4. Volume: 1,736,000 acre/feet.
5. Mean hydraulic retention time: 5.2 years.

### B. Tributary and Outlet:
(See Appendix A for flow data)

1. Tributaries -

| Name | Drainage area* | Mean flow* |
|---|---|---|
| Boy River | 400.0 $mi^2$ | 200.5 cfs |
| Portage Lake/Leech Lake Connection | 16.2 $mi^2$ | 7.2 cfs |
| Sucker Creek | 25.5 $mi^2$ | 11.1 cfs |
| Steamboat Lake/Steamboat Bay Connection | 130.0 $mi^2$ | 63.7 cfs |
| Swamp Lake/Steamboat River Connection | 11.8 $mi^2$ | 5.2 cfs |
| Kabekona Bay/Walker Bay Connection | 141.0 $mi^2$ | 69.6 cfs |
| Shingobee Creek | 28.4 $mi^2$ | 12.3 cfs |
| Minor tributaries & immediate drainage - | 112.1 $mi^2$ | 91.8 cfs |
| Total | 865.0 $mi^2$ | 461.4 cfs |

2. Outlet -

| | | |
|---|---|---|
| Leech Lake River | 1,040.0 $mi^2$** | 461.4 cfs |

† Schilling, 1974.
* Drainage areas are accurate within ±5%; mean daily flows are accurate within ±10%; and ungaged flows are accurate within ±10 to 25% for drainage areas greater than 10 $mi^2$.
** Includes area of lake.

C. Precipitation*:

1. Year of sampling: 26.7 inches.

2. Mean annual: 23.8 inches.

* See Working Paper No. 1, "Survey Methods".

## III. LAKE WATER QUALITY SUMMARY

Leech Lake was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from four stations on the lake and from a number of depths at each station (see map, page vi). During each visit, a single depth-integrated (15 feet or near bottom to surface) sample was collected from the stations for phytoplankton identification and enumeration; and during the last visit, a single five-gallon depth-integrated sample was collected for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 83 feet at station 1, 11 feet at station 2, 20 feet at station 3, and 18 feet at station 4.

The results obtained are presented in full in Appendix B, and the data for the fall sampling period, when the lake essentially was well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix B.

A. Physical and chemical characteristics:

| Parameter | Minimum | Mean | Median | Maximum |
|---|---|---|---|---|
| | | FALL VALUES (10/21/72) | | |
| Temperature (Cent.) | 3.9 | 5.5 | 5.5 | 7.8 |
| Dissolved oxygen (mg/l) | 10.4 | 11.6 | 11.4 | 14.0 |
| Conductivity (μmhos) | 252 | 261 | 261 | 265 |
| pH(units) | 8.1 | 8.2 | 8.3 | 8.3 |
| Alkalinity (mg/l) | 130 | 132 | 132 | 135 |
| Total P (mg/l) | 0.009 | 0.029 | 0.029 | 0.044 |
| Dissolved P (mg/l) | 0.003 | 0.021 | 0.023 | 0.038 |
| $NO_2$ + $NO_3$ (mg/l) | 0.040 | 0.046 | 0.045 | 0.060 |
| Ammonia (mg/l) | 0.050 | 0.067 | 0.070 | 0.090 |
| | | ALL VALUES | | |
| Secchi disc (inches) | 66 | 87 | 84 | 120 |

B. Biological characteristics:

1. Phytoplankton -

| Sampling Date | Dominant Genera | Number per ml |
|---|---|---|
| 07/11/72 | 1. Microcystis | 3,418 |
| | 2. Chroococcus | 778 |
| | 3. Fragilaria | 778 |
| | 4. Dinobryon | 416 |
| | 5. Anabaena | 325 |
| | Other genera | 2,495 |
| | Total | 8,210 |
| 09/08/72 | 1. Microcystis | 1,685 |
| | 2. Lyngbya | 1,338 |
| | 3. Anabaena | 383 |
| | 4. Aphanocapsa | 210 |
| | 5. Dinobryon | 181 |
| | Other genera | 484 |
| | Total | 4,281 |
| 10/21/72 | 1. Flagellates | 3,367 |
| | 2. Dinobryon | 2,764 |
| | 3. Microcystis | 1,849 |
| | 4. Lyngbya | 1,055 |
| | 5. Fragilaria | 704 |
| | Other genera | 3,075 |
| | Total | 12,814 |

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

| Sampling Date | Station Number | Chlorophyll a (µg/l) |
|---|---|---|
| 07/11/72 | 01 | 4.7 |
| | 02 | 6.9 |
| | 03 | 7.9 |
| | 04 | 8.7 |
| 09/08/72 | 01 | 7.5 |
| | 02 | 3.2 |
| | 03 | 8.4 |
| | 04 | 4.0 |
| 10/21/72 | 01 | 5.5 |
| | 02 | 5.5 |
| | 03 | 5.7 |
| | 04 | 6.9 |

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

| Spike (mg/l) | Ortho P Conc. (mg/l) | Inorganic N Conc. (mg/l) | Maximum yield (mg/l-dry wt.) |
|---|---|---|---|
| Control | 0.017 | 0.060 | 0.5 |
| 0.005 P | 0.022 | 0.060 | 0.6 |
| 0.010 P | 0.027 | 0.060 | 0.6 |
| 0.020 P | 0.037 | 0.060 | 0.6 |
| 0.050 P | 0.067 | 0.060 | 0.7 |
| 0.050 P + 10.0 N | 0.067 | 10.060 | 23.4 |
| 10.0 N | 0.017 | 10.060 | 2.8 |

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Leech Lake was relatively low at the time the assay sample

was collected. Also, the lack of significant change in yield with increased levels of orthophosphate until nitrogen was added shows that the lake was nitrogen limited at this time. Note that the addition of only nitrogen resulted in a yield greater than the control yield.

Nitrogen limitation is also indicated by the lake data obtained at the time the assay sample was collected (the N/P ratio was 5/1). However, during the July and September sampling the N/P ratio was greater than 14/1, and phosphorus limitation would be expected.

## IV. NUTRIENT LOADINGS
(See Appendix C for data)

For the determination of nutrient loadings, the Minnesota National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page vi), except for the high runoff months of April and May when two samples were collected. Sampling was begun in October, 1972, and was completed in September, 1973.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Minnesota District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated by using the mean of the nutrient loads, in lbs/$mi^2$/year, at stations C-1, D-1, F-1, G-1, H-1, and J-1 and multiplying the means by the ZZ area in $mi^2$.

The City of Walker and the Ah-Gwah-Ching Nursing Home did not participate in the Survey, and nutrient loads from these sources were estimated at 2.5 lbs P and 7.5 lbs N/capita/year.

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* See Working Paper No. 1.

A. Waste Sources:

1. Known municipal† -

| Name | Pop. Served | Treatment | Mean Flow (mgd) | Receiving Water |
|---|---|---|---|---|
| Walker | 1,073 | trickling filter | 0.107* | Leech Lake |
| Ah-Gwah-Ching Nursing Home | 473 | trickling filter | 0.047* | Leech Lake |

2. Known industrial - None

† Anonymous, 1974.
* Estimated at 100 gal/capita/day.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

| Source | lbs P/ yr | % of total |
|---|---|---|
| a. Tributaries (non-point load) - | | |
| Boy River | 8,000 | 20.2 |
| Portage Lake/Leech Lake Connection | 620 | 1.6 |
| Sucker Creek | 580 | 1.5 |
| Steamboat Lake/Steamboat Bay Connection | 2,020 | 5.1 |
| Swamp Lake/Steamboat River Connection | 260 | 0.7 |
| Kabekona Bay/Walker Bay Connection | 2,170 | 5.5 |
| Shingobee Creek | 1,480 | 3.7 |
| b. Minor tributaries & immediate drainage (non-point load) - | 3,140 | 7.9 |
| c. Known municipal STP's - | | |
| Walker | 2,680 | 6.8 |
| Ah-Gwah-Ching Nursing Home | 1,180 | 3.0 |
| d. Septic tanks* - | 10 | <0.1 |
| e. Known industrial - None | - | - |
| f. Direct precipitation** - | 17,470 | 44.1 |
| Total | 39,610 | 100.0 |

2. Outputs -

Lake outlet - Leech Lake River 18,130

3. Net annual P accumulation - 21,480 pounds

* Estimate based on Boy River population of 44 (1970 census); shoreline cottages not included (see Working Paper No. 1).
** See Working Paper No. 1.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

| Source | lbs N/ yr | % of total |
|---|---|---|
| a. Tributaries (non-point load) - | | |
| Boy River | 684,320 | 28.8 |
| Portage Lake/Leech Lake Connection | 20,240 | 0.9 |
| Sucker Creek | 27,100 | 1.1 |
| Steamboat Lake/Steamboat Bay Connection | 171,730 | 7.2 |
| Swamp Lake/Steamboat River Connection | 16,880 | 0.7 |
| Kabekona Bay/Walker Bay Connection | 191,310 | 8.1 |
| Shingobee Creek | 30,870 | 1.3 |
| b. Minor tributaries & immediate drainage (non-point load) - | 140,240 | 5.9 |
| c. Known municipal STP's - | | |
| Walker | 8,050 | 0.3 |
| Ah-Gwah-Ching Nursing Home | 3,550 | 0.2 |
| d. Septic tanks* - | 400 | <0.1 |
| e. Known industrial - None | - | - |
| f. Direct precipitation** - | 1,079,010 | 45.5 |
| Total | 2,373,810 | 100.0 |

2. Outputs -

Lake outlet - Leech Lake River 1,158,000

3. Net annual N accumulation - 1,215,850 pounds

* Estimate based on Boy River population of 44 (1970 census); shoreline cottages not included (see Working Paper No. 1).
** See Working Paper No. 1.

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

| Tributary | lbs P/mi$^2$/yr | lbs N/mi$^2$/yr |
|---|---|---|
| Boy River | 20 | 1,711 |
| Portage Lake/Leech Lake Connection | 38 | 1,249 |
| Sucker Creek | 23 | 1,063 |
| Steamboat Lake/Steamboat Bay Connection | 16 | 1,321 |
| Swamp Lake/Steamboat River Connection | 22 | 1,430 |
| Kabekona Bay/Walker Bay Connection | 15 | 1,357 |
| Shingobee Creek | 52 | 1,087 |

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (in press). Essentially, his "dangerous" rate is the rate at which the receiving waters would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and "permissible".

| | Total Phosphorus | | Total Nitrogen | |
|---|---|---|---|---|
| Units | Total | Accumulated | Total | Accumulated |
| lbs/acre/yr | 0.4 | 0.2 | 21.2 | 10.9 |
| grams/m$^2$/yr | 0.04 | 0.02 | 2.4 | 1.2 |

Vollenweider loading rates for phosphorus (g/m$^2$/yr) based on mean depth and mean hydraulic retention time of Leech Lake:

| | |
|---|---|
| "Dangerous" (eutrophic rate) | 0.18 |
| "Permissible" (oligotrophic rate) | 0.09 |

## V. LITERATURE REVIEWED

Anonymous, 1974. Wastewater disposal facilities inventory. MPCA, Minneapolis.

McGuire, John F., 1974. Personal communication (present status of treatment facilities at Leech Lake). MPCA, Minneapolis.

Schilling, Joel, 1974. Personal communication (lake morphometry). MPCA, Minneapolis.

Vollenweider, Richard A. (in press). Input-output models. Schweiz. A. Hydrol.

# VII. APPENDICES

## APPENDIX A

## TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR MINNESOTA 10/30/74

LAKE CODE 2746 LEECH LAKE

TOTAL DRAINAGE AREA OF LAKE 1040.00

| TRIBUTARY | SUB-DRAINAGE AREA | NORMALIZED FLOWS JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | MEAN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2746A1 | 400.00 | 95.20 | 114.00 | 109.00 | 369.00 | 349.00 | 282.00 | 186.00 | 178.00 | 129.00 | 257.00 | 213.00 | 132.00 | 200.45 |
| 2746B1 | 1040.00 | 441.70 | 421.70 | 336.30 | 229.50 | 372.30 | 497.70 | 528.40 | 595.10 | 621.80 | 589.80 | 460.40 | 437.70 | 461.45 |
| 2746C1 | 16.20 | 3.84 | 3.72 | 3.20 | 13.10 | 15.30 | 13.10 | 7.08 | 4.84 | 4.54 | 9.84 | 6.97 | 3.75 | 7.24 |
| 2746D1 | 25.50 | 3.46 | 4.75 | 5.12 | 10.40 | 22.90 | 19.60 | 11.00 | 7.43 | 7.00 | 14.30 | 19.80 | 6.09 | 11.10 |
| 2746F1 | 130.00 | 36.60 | 36.80 | 41.70 | 108.00 | 121.00 | 105.00 | 60.30 | 44.60 | 44.20 | 71.20 | 56.10 | 38.60 | 63.74 |
| 2746G1 | 11.40 | 1.94 | 1.76 | 2.59 | 8.76 | 10.80 | 9.91 | 5.51 | 3.66 | 4.58 | 6.12 | 4.28 | 2.79 | 5.23 |
| 2746H1 | 141.00 | 37.60 | 39.40 | 39.80 | 117.00 | 131.00 | 112.00 | 66.80 | 51.50 | 49.80 | 82.50 | 65.40 | 42.10 | 69.64 |
| 2746J1 | 28.40 | 4.31 | 4.97 | 6.54 | 21.70 | 23.50 | 20.10 | 12.30 | 10.30 | 9.72 | 15.40 | 11.30 | 7.61 | 12.34 |
| 2746Z7 | 287.10 | 20.84 | 26.70 | 38.00 | 242.72 | 195.84 | 209.20 | 93.58 | 55.82 | 49.60 | 67.31 | 67.51 | 33.50 | 91.70 |

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 1040.00
SUM OF SUB-DRAINAGE AREAS = 1040.00
TOTAL FLOW IN = 5532.90
TOTAL FLOW OUT = 5532.39

MEAN MONTHLY FLOWS AND DAILY FLOWS

| TRIBUTARY | MONTH | YEAR | MEAN FLOW | DAY | FLOW | DAY | FLOW | DAY | FLOW |
|---|---|---|---|---|---|---|---|---|---|
| 2746A1 | 10 | 72 | 164.10 | 15 | 167.00 | | | | |
| | 11 | 72 | 52.90 | 5 | 57.00 | | | | |
| | 12 | 72 | 190.00 | 12 | 182.00 | | | | |
| | 1 | 73 | 182.90 | 12 | 173.00 | | | | |
| | 2 | 73 | 143.00 | 17 | 139.00 | | | | |
| | 3 | 73 | 320.00 | 14 | 368.00 | | | | |
| | 4 | 73 | 161.00 | 4 | 159.00 | 15 | 151.00 | | |
| | 5 | 73 | 367.00 | 10 | 382.00 | 23 | 315.00 | | |
| | 6 | 73 | 282.20 | 19 | 256.00 | | | | |
| | 7 | 73 | 309.00 | 9 | 324.00 | | | | |
| | 8 | 73 | 303.00 | 7 | 282.00 | | | | |
| | 9 | 73 | 240.00 | 10 | 241.00 | | | | |
| 2746H1 | 10 | 72 | 478.00 | 15 | 912.00 | | | | |
| | 11 | 72 | 497.10 | 5 | 900.00 | | | | |
| | 12 | 72 | 798.00 | 16 | 770.00 | | | | |
| | 1 | 73 | 760.00 | 12 | 715.00 | | | | |
| | 2 | 73 | 775.00 | 17 | 717.00 | | | | |
| | 3 | 73 | 333.00 | 14 | 96.00 | | | | |
| | 4 | 73 | 99.00 | 4 | 99.00 | 15 | 99.00 | | |
| | 5 | 73 | 100.00 | 16 | 101.00 | 23 | 100.00 | | |
| | 6 | 73 | 102.60 | 19 | 102.00 | | | | |
| | 7 | 73 | 101.00 | 9 | 100.00 | | | | |
| | 8 | 73 | 104.00 | 7 | 104.00 | | | | |
| | 9 | 73 | 103.00 | 10 | 104.00 | | | | |

TRIBUTARY FLOW INFORMATION FOR MINNESOTA 10/30/74

LAKE CODE 2746 LEECH LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS

| TRIBUTARY | MONTH | YEAR | MEAN FLOW | DAY | FLOW | DAY | FLOW | DAY | FLOW |
|---|---|---|---|---|---|---|---|---|---|
| 2746C1 | 10 | 72 | 6.29 | 15 | 6.40 | | | | |
| | 11 | 72 | 1.73 | 5 | 1.80 | | | | |
| | 12 | 72 | 5.40 | 12 | 5.20 | | | | |
| | 1 | 73 | 5.02 | 12 | 4.80 | | | | |
| | 2 | 73 | 3.41 | 17 | 3.30 | | | | |
| | 3 | 73 | 9.41 | 18 | 11.00 | | | | |
| | 4 | 73 | 5.71 | 4 | 5.60 | 15 | 5.40 | | |
| | 5 | 73 | 16.10 | 10 | 17.00 | 23 | 13.80 | | |
| | 6 | 73 | 13.10 | 19 | 12.00 | | | | |
| | 7 | 73 | 11.80 | 9 | 12.00 | | | | |
| | 8 | 73 | 8.22 | 7 | 7.60 | | | | |
| | 9 | 73 | 10.60 | 10 | 12.00 | | | | |
| 2746D1 | 10 | 72 | 9.10 | 15 | 9.30 | | | | |
| | 11 | 72 | 2.54 | 5 | 2.80 | | | | |
| | 12 | 72 | 8.74 | 10 | 8.70 | | | | |
| | 1 | 73 | 8.48 | 12 | 8.10 | | | | |
| | 2 | 73 | 5.96 | 17 | 5.80 | | | | |
| | 3 | 73 | 15.60 | 18 | 18.00 | | | | |
| | 4 | 73 | 8.65 | 4 | 8.60 | 15 | 8.10 | | |
| | 5 | 73 | 24.10 | 10 | 25.00 | 23 | 21.00 | | |
| | 6 | 73 | 19.60 | 19 | 18.00 | | | | |
| | 7 | 73 | 18.40 | 9 | 19.00 | | | | |
| | 8 | 73 | 13.30 | 7 | 12.00 | | | | |
| | 9 | 73 | 16.20 | 10 | 18.00 | | | | |
| 2746F1 | 10 | 72 | 45.40 | 15 | 46.00 | | | | |
| | 11 | 72 | 13.90 | 5 | 15.00 | | | | |
| | 12 | 72 | 55.70 | 10 | 55.00 | | | | |
| | 1 | 73 | 78.53 | 12 | 75.00 | | | | |
| | 2 | 73 | 46.80 | 17 | 45.00 | | | | |
| | 3 | 73 | 122.00 | 18 | 140.00 | | | | |
| | 4 | 73 | 47.50 | 4 | 47.00 | 15 | 45.00 | | |
| | 5 | 73 | 127.00 | 10 | 132.00 | 23 | 109.00 | | |
| | 6 | 73 | 105.30 | 19 | 96.00 | | | | |
| | 7 | 73 | 100.30 | 9 | 105.00 | | | | |
| | 8 | 73 | 75.80 | 7 | 70.00 | | | | |
| | 9 | 73 | 103.00 | 10 | 117.00 | | | | |
| 2746G1 | 10 | 72 | 3.90 | 15 | 4.00 | | | | |
| | 11 | 72 | 1.06 | 5 | 1.10 | | | | |
| | 12 | 72 | 4.02 | 10 | 4.00 | | | | |
| | 1 | 73 | 4.16 | 12 | 4.00 | | | | |
| | 2 | 73 | 2.21 | 17 | 2.10 | | | | |
| | 3 | 73 | 7.60 | 18 | 8.70 | | | | |
| | 4 | 73 | 3.83 | 4 | 3.80 | 15 | 3.60 | | |
| | 5 | 73 | 11.30 | 10 | 12.00 | 23 | 9.70 | | |
| | 6 | 73 | 9.81 | 19 | 8.90 | | | | |
| | 7 | 73 | 9.15 | 9 | 9.60 | | | | |
| | 8 | 73 | 6.21 | 7 | 5.80 | | | | |
| | 9 | 73 | 10.60 | 10 | 12.00 | | | | |

TRIBUTARY FLOW INFORMATION FOR MINNESOTA 10/30/74

LAKE CODE 2746 LEECH LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS

| TRIBUTARY | MONTH | YEAR | MEAN FLOW | DAY | FLOW | DAY | FLOW | DAY | FLOW |
|---|---|---|---|---|---|---|---|---|---|
| 2746H1 | 10 | 72 | 52.60 | 15 | 54.00 | | | | |
| | 11 | 72 | 16.20 | 5 | 17.00 | | | | |
| | 12 | 72 | 51.70 | 13 | 58.00 | | | | |
| | 1 | 73 | 40.50 | 12 | 76.00 | | | | |
| | 2 | 73 | 49.40 | 17 | 48.00 | | | | |
| | 3 | 73 | 117.00 | 18 | 135.00 | | | | |
| | 4 | 73 | 51.20 | 4 | 51.00 | 15 | 48.00 | | |
| | 5 | 73 | 138.10 | 10 | 143.00 | 23 | 118.00 | | |
| | 6 | 73 | 112.30 | 19 | 102.00 | | | | |
| | 7 | 73 | 111.60 | 9 | 117.00 | | | | |
| | 8 | 73 | 87.50 | 7 | 51.00 | | | | |
| | 9 | 73 | 116.00 | 10 | 132.00 | | | | |
| 2746J1 | 10 | 72 | 9.85 | 15 | 10.00 | | | | |
| | 11 | 72 | 2.80 | 5 | 3.00 | | | | |
| | 12 | 72 | 11.00 | 13 | 11.00 | | | | |
| | 1 | 73 | 9.24 | 12 | 8.80 | | | | |
| | 2 | 73 | 5.23 | 17 | 5.00 | | | | |
| | 3 | 73 | 19.21 | 14 | 22.00 | | | | |
| | 4 | 73 | 5.44 | 4 | 9.40 | 15 | 8.90 | | |
| | 5 | 73 | 24.73 | 10 | 26.00 | 23 | 21.00 | | |
| | 6 | 73 | 25.10 | 19 | 18.00 | | | | |
| | 7 | 73 | 20.40 | 9 | 21.00 | | | | |
| | 8 | 73 | 17.40 | 7 | 16.00 | | | | |
| | 9 | 73 | 22.50 | 10 | 26.00 | | | | |
| 2746J7 | 10 | 72 | 40.50 | 15 | 42.00 | | | | |
| | 11 | 72 | 16.20 | 5 | 17.00 | | | | |
| | 12 | 72 | 45.20 | 13 | 44.00 | | | | |
| | 1 | 73 | 42.50 | 12 | 40.00 | | | | |
| | 2 | 73 | 32.20 | 17 | 31.00 | | | | |
| | 3 | 73 | 127.00 | 18 | 123.00 | | | | |
| | 4 | 73 | 134.00 | 4 | 103.00 | 15 | 98.00 | | |
| | 5 | 73 | 203.00 | 10 | 208.00 | 23 | 172.00 | | |
| | 6 | 73 | 204.00 | 19 | 146.00 | | | | |
| | 7 | 73 | 151.00 | 9 | 158.00 | | | | |
| | 8 | 73 | 81.70 | 7 | 85.00 | | | | |
| | 9 | 73 | 110.00 | 16 | 125.00 | | | | |

# APPENDIX B

## PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/10/30

274601
47 07 00.0 094 35 00.0
LEECH LAKE
21 MINNESOTA

11EPALES 2111202
4 0036 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00010 WATER TEMP CENT | 00300 DO MG/L | 00077 TRANSP SECCHI INCHES | 00094 CNDUCTVY FIELD MICROMHO | 00400 PH SU | 00410 T ALK CACO3 MG/L | 00630 NO2&NO3 N-TOTAL MG/L | 00610 NH3-N TOTAL MG/L | 00665 PHOS-TOT MG/L P | 00666 PHOS-DIS MG/L P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 72/07/11 | 14 00 | 0000 | | | 120 | | | | | | | |
| | 14 00 | 0004 | 22.7 | 9.2 | | 280 | 8.30 | 145 | 0.080 | 0.090 | 0.013 | 0.008 |
| | 14 00 | 0015 | 20.7 | 9.0 | | 300 | 7.70 | 144 | 0.070 | 0.080 | 0.019 | 0.018 |
| | 14 00 | 0030 | 14.7 | 6.6 | | 300 | 7.70 | 149 | 0.100 | 0.040 | 0.015 | 0.006 |
| | 14 00 | 0036 | 12.8 | 6.2 | | 310 | 7.50 | 154 | 0.080 | 0.060 | 0.011 | 0.005 |
| 72/09/08 | 15 30 | 0000 | | | 108 | 242 | 8.35 | 133 | 0.060 | 0.080 | 0.014 | 0.007 |
| | 15 30 | 0004 | | 8.8 | | 242 | 8.35 | 128 | 0.050 | 0.060 | 0.015 | 0.007 |
| | 15 30 | 0015 | 18.0 | 8.6 | | 242 | 8.30 | 129 | 0.040 | 0.060 | 0.015 | 0.010 |
| | 15 30 | 0029 | 17.9 | 8.5 | | 248 | 8.30 | 130 | 0.040 | 0.070 | 0.014 | 0.010 |
| | 15 30 | 0026 | 17.4 | 8.2 | | 242 | 8.35 | 128 | 0.050 | 0.070 | 0.026 | 0.013 |
| | 15 30 | 0033 | 17.7 | 8.4 | | 245 | 8.35 | 127 | 0.050 | 0.060 | 0.013 | 0.006 |
| | 15 30 | 0043 | 14.5 | 2.6 | | 262 | 7.60 | 141 | 0.080 | 0.060 | 0.014 | 0.007 |
| | 15 30 | 0053 | 11.8 | 1.0 | | 270 | 7.40 | 148 | 0.120 | 0.050 | 0.013 | 0.008 |
| | 15 30 | 0063 | 10.4 | 1.0 | | 270 | 7.40 | 147 | 0.110 | 0.040 | 0.013 | 0.009 |
| | 15 30 | 0073 | 8.7 | 1.1 | | 275 | 7.35 | 152 | 0.170 | 0.050 | 0.013 | 0.009 |
| | 15 30 | 0083 | 7.8 | 1.3 | | 275 | 7.30 | 148 | 0.220 | 0.040 | 0.021 | 0.013 |
| 72/10/21 | 16 00 | 0000 | | | 80 | 265 | 8.20 | 135 | 0.040 | 0.060 | 0.043 | 0.037 |
| | 16 00 | 0004 | 7.8 | 10.4 | | 260 | 8.10 | 134 | 0.040 | 0.060 | 0.036 | 0.030 |
| | 16 00 | 0015 | 7.1 | 10.8 | | 260 | 8.20 | 134 | 0.040 | 0.050 | 0.030 | 0.025 |
| | 16 00 | 0025 | 6.4 | 11.2 | | 255 | 8.20 | 135 | 0.040 | 0.050 | 0.029 | 0.024 |
| | 16 00 | 0040 | 6.3 | 11.3 | | 262 | 8.20 | 132 | 0.040 | 0.050 | 0.036 | 0.029 |
| | 16 00 | 0050 | 6.3 | 11.3 | | 262 | 8.20 | 132 | 0.040 | 0.050 | 0.044 | 0.038 |
| | 16 00 | 0061 | 6.5 | 11.2 | | 262 | 8.20 | 133 | 0.050 | 0.060 | 0.039 | 0.023 |

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 32217 CHLRPHYL A UG/L |
|---|---|---|---|
| 72/07/11 | 14 00 | 0000 | 4.7J |
| 72/09/08 | 15 30 | 0000 | 7.5J |
| 72/10/21 | 16 00 | 0000 | 5.5J |

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 74/10/30

274602
47 11 40.0 094 28 50.0
LEECH LAKE
27 MINNESOTA

11EPALES
4

2111202
0008 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00010 WATER TEMP CENT | 00300 DO MG/L | 00077 TRANSP SECCHI INCHES | 00094 CNDUCTVY FIELD MICROMHO | 00400 PH SU | 00410 T ALK CACO3 MG/L | 00630 NO2&NO3 N-TOTAL MG/L | 00610 NH3-N TOTAL MG/L | 00665 PHOS-TOT MG/L P | 00666 PHOS-DIS MG/L P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 72/07/11 | 14 45 | 0000 | | | 96 | | | | | | | |
| | 14 45 | 0004 | 21.7 | 8.8 | | 280 | 8.10 | 142 | 0.070 | 0.080 | 0.015 | 0.009 |
| | 14 45 | 0008 | 21.4 | 9.0 | | 280 | 8.10 | 144 | 0.050 | 0.060 | 0.016 | |
| 72/09/08 | 16 25 | 0000 | | | 66 | 240 | 8.40 | 126 | 0.080 | 0.100 | 0.016 | 0.007 |
| | 16 25 | 0004 | 18.0 | 8.8 | | 239 | 8.40 | 127 | 0.070 | 0.090 | 0.016 | 0.008 |
| | 16 25 | 0011 | 17.2 | 9.4 | | 240 | 8.40 | 127 | 0.070 | 0.090 | 0.015 | 0.009 |
| 72/10/21 | 17 10 | 0000 | | | 68 | 265 | 8.30 | 131 | 0.050 | 0.080 | 0.009 | 0.003 |
| | 17 10 | 0004 | 4.0 | 12.4 | | 260 | 8.30 | 131 | 0.040 | 0.070 | 0.019 | 0.013 |
| | 17 10 | 0009 | 3.9 | 14.0 | | 262 | 8.30 | 131 | 0.040 | 0.080 | 0.020 | 0.012 |

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 32217 CHLRPHYL A UG/L |
|---|---|---|---|
| 72/07/11 | 14 45 | 0000 | 6.9J |
| 72/09/08 | 16 25 | 0000 | 3.2J |
| 72/10/21 | 17 10 | 0000 | 5.5J |

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 74/10/30

274603
47 13 00.0 094 20 10.0
LEECH LAKE
27 MINNESOTA

11EPALES 2111202
4 0018 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00010 WATER TEMP CENT | 00300 DO MG/L | 00077 TRANSP SECCHI INCHES | 00094 CNDUCTVY FIELD MICROMHO | 00400 PH SU | 00410 T ALK CACO3 MG/L | 00630 NO2&NO3 N-TOTAL MG/L | 00610 NH3-N TOTAL MG/L | 00665 PHOS-TOT MG/L P | 00666 PHOS-DIS MG/L P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 72/07/11 | 15 00 | 0000 | | | 96 | | | | | | | |
| | 15 00 | 0004 | 21.7 | 8.6 | | 280 | 8.30 | 136 | 0.040 | 0.060 | 0.013 | |
| | 15 00 | 0015 | 21.1 | | | 280 | 8.20 | 138 | 0.050 | 0.070 | 0.013 | |
| | 15 00 | 0018 | 21.1 | 9.0 | | 280 | 8.20 | 142 | 0.060 | 0.080 | 0.011 | 0.009 |
| 72/09/08 | 16 45 | 0000 | | | 84 | 245 | 8.30 | 131 | 0.070 | 0.110 | 0.015 | 0.009 |
| | 16 45 | 0004 | 18.3 | 8.6 | | 258 | 8.30 | 131 | 0.060 | 0.100 | 0.018 | 0.008 |
| | 16 45 | 0015 | 17.6 | 8.3 | | 260 | 8.25 | 129 | 0.060 | 0.100 | 0.013 | 0.007 |
| | 16 45 | 0020 | 17.6 | 8.2 | | 245 | 8.30 | 129 | 0.060 | 0.090 | 0.014 | 0.007 |
| 72/10/21 | 16 50 | 0000 | | | 72 | 262 | 8.30 | 131 | 0.060 | 0.090 | 0.016 | 0.007 |
| | 16 50 | 0004 | 4.5 | 11.8 | | 252 | 8.30 | 131 | 0.060 | 0.070 | 0.029 | 0.022 |
| | 16 50 | 0015 | 4.4 | 11.7 | | 262 | 8.30 | 130 | 0.050 | 0.070 | 0.027 | 0.020 |

23

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 32217 CHLRPHYL A UG/L |
|---|---|---|---|
| 72/07/11 | 15 00 | 0000 | 7.9J |
| 72/09/08 | 16 45 | 0000 | 8.4J |
| 72/10/21 | 16 50 | 0000 | 5.7J |

J VALUE KNOWN TO BE [illegible]

STORET RETRIEVAL DATE 74/10/30

274604
47 05 30.0 094 23 00.0
LEECH LAKE
27 MINNESOTA

11EPALES 2111202
4 0015 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00010 WATER TEMP CENT | 00300 DO MG/L | 00077 TRANSP SECCHI INCHES | 00094 CNDUCTVY FIELD MICROMHO | 00400 PH SU | 00410 T ALK CACO3 MG/L | 00630 NO2&NO3 N-TOTAL MG/L | 00610 NH3-N TOTAL MG/L | 00665 PHOS-TOT MG/L P | 00666 PHOS-DIS MG/L P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 72/07/11 | 15 | 35 0000 | | | 90 | | | | | | | |
| | 15 | 35 0004 | 22.2 | 9.9 | | 280 | 8.30 | 136 | 0.050 | 0.070 | 0.014 | 0.011 |
| | 15 | 35 0015 | 20.7 | 8.2 | | 285 | 8.10 | 136 | 0.050 | 0.060 | 0.014 | |
| 72/09/08 | 15 | 05 0000 | | | | 240 | 8.30 | 128 | 0.070 | 0.100 | 0.014 | 0.010 |
| | 15 | 05 0004 | 18.0 | 9.2 | | 239 | 8.35 | 128 | 0.060 | 0.080 | 0.016 | 0.008 |
| | 15 | 05 0015 | 17.2 | 9.4 | | 240 | 8.30 | 128 | 0.070 | 0.090 | 0.018 | 0.008 |
| | 15 | 05 0018 | 17.2 | 10.0 | | 240 | 8.30 | 129 | 0.070 | 0.080 | 0.014 | 0.007 |
| 72/10/21 | 16 | 35 0000 | | | 72 | 260 | 8.30 | 131 | 0.050 | 0.080 | 0.014 | 0.007 |
| | 16 | 35 0004 | 4.7 | 11.8 | | 260 | 8.30 | 131 | 0.050 | 0.070 | 0.038 | 0.029 |
| | 16 | 35 0015 | 4.7 | 11.8 | | 260 | 8.30 | 132 | 0.050 | 0.080 | 0.035 | 0.025 |

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 32217 CHLRPHYL A UG/L |
|---|---|---|---|
| 72/07/11 | 15 | 35 0000 | 8.7J |
| 72/09/08 | 15 | 05 0000 | 4.0J |
| 72/10/21 | 16 | 35 0000 | 6.9J |

J VALUE [illegible]

# APPENDIX C

# TRIBUTARY DATA

STORET RETRIEVAL DATE 74/10/30

2746A1 LS2746A1
47 10 00.0 093 11 00.0
HOY RIVER
27 CO #11. SHEET #4
1/LEECH LAKE
CO HWY 8 BRDG 2.5 MI W OF HOY RIVER
11EPALES 2111204
4 0000 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00630 NO2&NO3 N-TOTAL MG/L | 00625 TOT KJEL N MG/L | 00610 NH3-N TOTAL MG/L | 00671 PHOS-DIS ORTHO MG/L P | 00665 PHOS-TOT MG/L P |
|---|---|---|---|---|---|---|---|
| 72/10/15 | | | 0.117 | 0.665 | 0.120 | 0.005K | 0.014 |
| 72/11/05 | 13 50 | | 0.015 | 0.460 | 0.005K | 0.006 | 0.015 |
| 73/03/18 | 02 40 | | 0.046 | 2.000 | 0.110 | 0.016 | 0.035 |
| 73/04/04 | 13 30 | | 0.010K | 1.600 | 0.052 | 0.005K | 0.025 |
| 73/04/15 | 15 30 | | 0.010K | 1.380 | 0.026 | 0.006 | 0.020 |
| 73/05/10 | 14 05 | | 0.014 | 2.600 | 0.061 | | 0.023 |
| 73/05/23 | 21 30 | | 0.010K | 2.940 | 0.068 | 0.008 | 0.030 |
| 73/06/19 | 14 15 | | 0.036 | 0.860 | 0.021 | 0.010 | 0.015 |
| 73/07/09 | 13 50 | | 0.010K | 3.000 | 0.030 | 0.005K | 0.015 |
| 73/08/07 | 14 30 | | 0.010K | 0.860 | 0.027 | 0.012 | 0.015 |
| 73/09/10 | 13 40 | | 0.010K | 2.310 | 0.028 | 0.005K | 0.015 |

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 74/10/30

274631 LS2746B1
47 14 30.0 093 13 00.0
LEECH LAKE RIVER
27 CO #11,SHEET #4
0/LEECH LAKE
CO HWY 8 BRDG AT FEDERAL DAM
11EPALES 2111204
4 0000 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00630 NO2&NO3 N-TOTAL MG/L | 00625 TOT KJEL N MG/L | 00610 NH3-N TOTAL MG/L | 00671 PHOS-DIS ORTHO MG/L P | 00665 PHOS-TOT MG/L P |
|---|---|---|---|---|---|---|---|
| 72/10/15 | 12 10 | | 0.060 | 0.775 | 0.096 | 0.008 | 0.026 |
| 72/11/05 | 13 40 | | 0.010K | 0.460 | 0.005K | 0.005K | 0.015 |
| 72/12/10 | 13 05 | | 2.100 | 1.050 | 0.150 | 0.020 | 0.056 |
| 73/01/12 | 13 15 | | 0.015 | 0.560 | 0.039 | 0.006 | 0.006 |
| 73/02/17 | 10 55 | | 0.026 | 0.560 | 0.040 | 0.006 | 0.010 |
| 73/03/14 | 14 30 | | 0.033 | 0.840 | 0.092 | 0.008 | 0.015 |
| 73/04/04 | 13 20 | | 0.010K | 0.660 | 0.052 | 0.005K | 0.025 |
| 73/04/15 | 15 20 | | 0.018 | 3.300 | 0.087 | 0.005K | 0.020 |
| 73/05/10 | 13 40 | | 0.010K | 0.750 | 0.012 | 0.011 | 0.020 |
| 73/05/23 | 21 15 | | 0.037 | 2.160 | 0.052 | 0.011 | 0.030 |
| 73/06/19 | 14 00 | | 0.017 | 0.920 | 0.031 | 0.008 | 0.020 |
| 73/07/06 | 13 40 | | 0.010K | 2.200 | 0.050 | 0.005K | 0.020 |
| 73/08/07 | 14 20 | | 0.010K | 0.540 | 0.024 | 0.008 | 0.020 |
| 73/09/10 | 13 30 | | 0.010K | 1.540 | 0.017 | 0.005K | 0.020 |

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 74/10/30

2746C1 LS2746C1
47 19 00.0 093 18 00.0
PORTAG LK/LEECH LK CONNECTION
27 CO #11,SHEET #4
T/LEECH LAKE
XING 5 MI WSW OF AENA
11EPALFS 2111204
4 0000 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00630 NO2&NO3 N-TOTAL MG/L | 00625 TOT KJEL N MG/L | 00610 NH3-N TOTAL MG/L | 00671 PHOS-DIS ORTHO MG/L P | 00665 PHOS-TOT MG/L P |
|---|---|---|---|---|---|---|---|
| 72/10/15 | 11 00 | | 0.045 | 0.550 | 0.075 | 0.005K | 0.019 |
| 72/11/05 | 13 15 | | 0.020 | 0.600 | 0.005K | 0.005K | 0.028 |
| 73/03/14 | 13 50 | | 0.125 | 1.800 | 0.110 | 0.006 | 0.030 |
| 73/04/04 | 13 00 | | 0.010K | 0.690 | 0.061 | 0.005K | 0.035 |
| 73/04/15 | 14 55 | | 0.058 | 3.300 | 0.126 | 0.006 | 0.045 |
| 73/05/10 | 13 10 | | 0.021 | 1.300 | 0.320 | 0.035 | 0.115 |
| 73/05/23 | 20 45 | | 0.010K | 1.200 | 0.042 | 0.021 | 0.070 |
| 73/06/19 | 13 35 | | 0.033 | 0.720 | 0.031 | 0.022 | 0.045 |
| 73/07/09 | 13 30 | | 0.012 | 3.000 | 0.580 | 0.023 | 0.050 |
| 73/04/07 | 13 50 | | 0.010K | 0.767 | 0.019 | 0.013 | 0.025 |
| 73/09/10 | 13 10 | | 0.010K | 1.260 | 0.355 | 0.005K | 0.020 |

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 74/10/30

274601 LS274601
47 19 30.0 093 26 00.0
SUCKER CREEK
27 CO #11. SHEET #4
T/LEECH LAKE
AING DOWNSTREAM OF LOWER SUCKER LAKE
11EPALES 2111204
4 0000 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00630 NO2&NO3 N-TOTAL MG/L | 00625 TOT KJEL N MG/L | 00610 NH3-N TOTAL MG/L | 00671 PHOS-DIS ORTHO MG/L P | 00665 PHOS-TOT MG/L P |
|---|---|---|---|---|---|---|---|
| 72/10/15 | 11 30 | | 0.034 | 0.865 | 0.087 | 0.005K | 0.033 |
| 72/11/05 | 13 50 | | 0.016 | 0.685 | 0.005K | 0.005K | 0.031 |
| 72/12/10 | 12 30 | | 0.010K | 0.440 | 0.005K | 0.005K | 0.010 |
| 73/01/12 | 12 30 | | 0.011 | 0.800 | 0.062 | 0.005K | 0.015 |
| 73/02/17 | 10 15 | | 0.066 | 0.980 | 0.060 | 0.005K | 0.015 |
| 73/03/18 | 13 20 | | 0.154 | 1.600 | 0.078 | 0.005K | 0.015 |
| 73/04/15 | 14 30 | | 0.090 | 1.300 | 0.110 | 0.005K | 0.040 |
| 73/05/10 | 12 40 | | 0.016 | 1.400 | 0.105 | 0.013 | 0.040 |
| 73/05/23 | 20 30 | | 0.010K | 1.300 | 0.048 | 0.008 | 0.027 |
| 73/06/19 | 13 10 | | 0.010K | 0.980 | 0.027 | 0.008 | 0.025 |
| 73/07/09 | 13 35 | | 0.010K | 3.400 | 0.097 | 0.015 | 0.025 |
| 73/08/07 | 13 30 | | 0.010K | 0.710 | 0.021 | 0.010 | 0.025 |
| 73/09/10 | 12 50 | | 0.010K | 1.050 | 0.052 | 0.007 | 0.045 |

K VALUE KNOWN TO BE LESS
THAN INDICATED

STORET RETRIEVAL DATE 74/10/30

2746F1 LS2746F1
47 16 00.0 093 38 00.0
STEAMBOAT LK/STEAMBOAT BAY CONN
27 CO #11, SHEET #4
T/LEECH LAKE
US 371 BRDG 7 MI S OF CASS LAKE CITY
11EPALES 2111204
4 0000 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00630 NO2&NO3 N-TOTAL MG/L | 00625 TOT KJEL N MG/L | 00610 NH3-N TOTAL MG/L | 00671 PHOS-DIS ORTHO MG/L P | 00665 PHOS-TOT MG/L P |
|---|---|---|---|---|---|---|---|
| 72/10/15 | 10 30 | | 0.010K | 0.620 | 0.048 | 0.005K | 0.026 |
| 72/11/05 | 11 20 | | 0.010K | 0.400 | 0.005K | 0.005K | 0.015 |
| 72/12/10 | 11 10 | | 0.012 | 0.730 | 0.022 | 0.005K | 0.017 |
| 73/01/12 | 11 25 | | 0.010K | 0.500 | 0.022 | 0.005K | 0.010 |
| 73/02/17 | 09 30 | | 0.010K | 0.440 | 0.028 | 0.005K | 0.010 |
| 73/03/18 | 11 55 | | 0.060 | 1.100 | 0.120 | 0.005K | 0.017 |
| 73/04/04 | 11 40 | | 0.019 | 1.600 | 0.370 | 0.005K | 0.015 |
| 73/04/15 | 13 05 | | 0.039 | 2.200 | 0.078 | 0.005K | 0.020 |
| 73/05/10 | 11 25 | | 0.010K | 1.760 | 0.052 | | 0.015 |
| 73/05/23 | 19 15 | | 0.010K | 0.800 | 0.020 | 0.007 | 0.020 |
| 73/06/19 | 11 45 | | 0.011 | 1.100 | 0.029 | 0.007 | 0.020 |
| 73/07/04 | 11 35 | | 0.027 | 4.800 | 0.154 | 0.005K | 0.015 |
| 73/08/07 | 11 55 | | 0.010K | 0.460 | 0.015 | 0.005K | 0.010 |
| 73/09/10 | 11 15 | | 0.010K | 2.400 | 0.034 | 0.005K | 0.015 |

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 74/10/30

2746G1 LS2746G1
47 13 30.0 093 38 00.0
SWAMP LAKE/STEAMBOAT RIVER CONN
27 CO #11, SHEET #4
T/LEECH LAKE
US 371 BRDG 1.5 MI S OF WILKINSON
11EPALES 2111204
4 0000 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00630 NO2&NO3 N-TOTAL MG/L | 00625 TOT KJEL N MG/L | 00610 NH3-N TOTAL MG/L | 00671 PHOS-DIS ORTHO MG/L P | 00665 PHOS-TOT MG/L P |
|---|---|---|---|---|---|---|---|
| 72/10/15 | 10 | 25 | 0.034 | 0.690 | 0.069 | 0.005K | 0.017 |
| 72/11/05 | 11 | 10 | 0.010K | 0.820 | 0.005K | 0.005K | 0.013 |
| 72/12/10 | 11 | 00 | 0.010K | 0.440 | 0.007 | 0.005K | 0.011 |
| 73/01/12 | 11 | 10 | 0.010K | 1.050 | 0.100 | 0.005K | 0.020 |
| 73/03/18 | 11 | 40 | 0.038 | 1.620 | 0.130 | 0.005K | 0.030 |
| 73/04/04 | 11 | 30 | 0.010K | 1.800 | 0.110 | 0.005K | 0.015 |
| 73/04/15 | 12 | 55 | 0.027 | 2.800 | 0.095 | 0.005K | 0.020 |
| 73/05/10 | 11 | 15 | 0.016 | 2.600 | 0.096 | 0.012 | 0.030 |
| 73/05/23 | 18 | 55 | 0.020 | 1.760 | 0.058 | 0.007 | 0.015 |
| 73/06/19 | 11 | 35 | 0.024 | 1.320 | 0.132 | 0.011 | 0.035 |
| 73/07/09 | 11 | 30 | 0.011 | 2.650 | 0.450 | 0.016 | 0.075 |
| 73/08/07 | 11 | 45 | 0.010K | 1.200 | 0.063 | 0.012 | 0.035 |
| 73/09/10 | 11 | 10 | 0.019 | 2.360 | 0.700 | 0.005K | 0.020 |

K VALUE KNOWN TO BE LESS
THAN INDICATED

STORET RETRIEVAL DATE 74/10/30

27464H1 LS2746H1
47 08 00.0 094 37 30.0
KABEKONA BAY/WALKER BAY CONN
27 CO #11. SHEET #2
T/LEECH LAKE
US 371 BRDG 2.5 MI NW OF W ALKER
11EPALES 2111204
4 0000 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00630 NO2&NO3 N-TOTAL MG/L | 00625 TOT KJEL N MG/L | 00610 NH3-N TOTAL MG/L | 00671 PHOS-DIS ORTHO MG/L P | 00665 PHOS-TOT MG/L P |
|---|---|---|---|---|---|---|---|
| 72/10/15 | 10 10 | | 0.026 | 0.690 | 0.082 | 0.005K | 0.015 |
| 72/11/05 | 11 00 | | 0.010K | 0.580 | 0.005K | 0.005K | 0.013 |
| 73/03/13 | 11 30 | | 0.160 | 0.520 | 0.210 | 0.008 | 0.030 |
| 73/04/04 | 11 20 | | 0.054 | 2.800 | 0.115 | 0.005K | 0.010 |
| 73/04/15 | 12 45 | | 0.022 | 2.800 | 0.080 | 0.005K | 0.010 |
| 73/05/10 | 10 50 | | 0.010K | 2.400 | 0.050 | 0.010 | 0.015 |
| 73/05/23 | 18 40 | | 0.010K | 1.260 | 0.030 | 0.007 | 0.015 |
| 73/06/13 | 11 35 | | 0.013 | 0.840 | 0.036 | 0.006 | 0.015 |
| 73/07/09 | 11 20 | | 0.010K | 0.960 | 0.033 | 0.005K | 0.015 |
| 73/08/07 | 11 35 | | 0.010K | 0.500 | 0.015 | 0.005K | 0.015 |
| 73/09/10 | 11 00 | | 0.010K | 1.500 | 0.048 | 0.005K | 0.020 |

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 74/10/30

2746J1 LS2746J1
47 01 30.0 094 36 00.0
SHINGOHEE CREEK
27 CO #11, SHEET #2
T/LEECH LAKE
CO HWY 50 BRDG 3.5 MI S OF WALKER
11EPALES 2111204
4 0000 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00630 NO2&NO3 N-TOTAL MG/L | 00625 TOT KJEL N MG/L | 00610 NH3-N TOTAL MG/L | 00671 PHOS-DIS ORTHO MG/L P | 00665 PHOS-TOT MG/L P |
|---|---|---|---|---|---|---|---|
| 72/10/15 | 09 | 50 | 0.030 | 0.265 | 0.052 | 0.011 | 0.040 |
| 72/11/05 | 10 | 20 | 0.057 | 0.300 | 0.005K | 0.007 | 0.027 |
| 73/03/18 | 11 | 00 | 0.170 | 0.460 | 0.220 | 0.014 | 0.045 |
| 73/04/04 | 11 | 00 | 0.055 | 0.660 | 0.110 | 0.052 | 0.060 |
| 73/04/15 | 12 | 15 | 0.100 | 2.100 | 0.210 | 0.014 | 0.060 |
| 73/05/10 | 10 | 30 | 0.037 | 0.560 | 0.037 | 0.019 | 0.055 |
| 73/05/23 | 18 | 20 | 0.073 | 3.360 | 0.140 | 0.029 | 0.090 |
| 73/06/19 | 11 | 05 | 0.015 | 1.100 | 0.032 | 0.030 | 0.065 |
| 73/07/09 | 10 | 55 | 0.011 | 2.800 | 0.126 | 0.044 | 0.092 |
| 73/08/07 | 11 | 15 | 0.010K | 0.310 | 0.013 | 0.037 | 0.080 |
| 73/09/10 | 10 | 45 | 0.018 | 1.050 | 0.052 | 0.024 | 0.065 |

K VALUE KNOWN TO BE LESS THAN INDICATED